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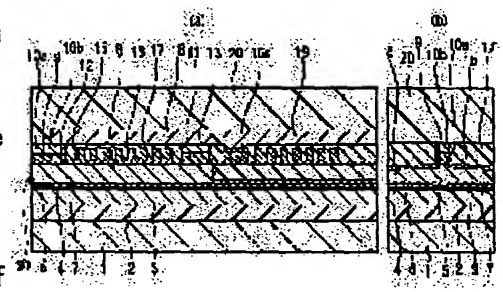
(54) THIN-FILM MAGNETIC HEAD AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a thin-film magnetic head, in which the track width and throat height can be prescribed with good accuracy, even when the track width of an induction-type magnetic conversion element is reduced.
SOLUTION: A recording head is provided with a lower-layer magnetic pole layer 8 and an upper-part magnetic layer, which face each other through a recording gap layer 9 and which contain magnetic pole parts. The recording head is provided with a thin-film coil 16. The upper-part magnetic layer is provided with a first magnetic-pole part layer 10a, whose width is equal to a recording track width and whose length is equal to the throat h ight. The upper-part magnetic layer is provided with a second magnetic-pole part layer 10b, in which the width of a part coming into contact with the first magnetic-pole part layer 10a is equal to the width of the first magnetic-pole part layer 10a, i.e., the recording track width, and whose total length is larger than the length of the first magnetic-pole part layer 10a. The upper-part magnetic pole layer is provided with a yoke-part layer 18. The first magnetic-pole part layer 10a is formed so as to have a width larger than the recording track width in the beginning, and it is set to a width which is equal to the recording track width after it is etched, by making use of the second magnetic-pole part layer 10b as a mask.



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CLAIMS

[Claim(s)]
[Claim 1] The medium opposed face which is characterized by providing the following and which counters a record medium, The 1st and 2nd magnetic layers which contain at least one layer including the magnetic pole portion which each other is connected magnetically and counters the aforementioned medium opposed face side mutually, respectively, The thin film magnetic head equipped with the gap layer prepared between the magnetic pole portion of the 1st magnetic layer of the above, and the magnetic pole portion of the 2nd magnetic layer of the above, and the thin film coil with which the part [at least] was prepared in the state where it insulated to the above 1st and the 2nd magnetic layer between the above 1st and the 2nd magnetic layer. One magnetic layer is the 1st magnetic pole partial layer which one field adjoins the aforementioned record gap layer, width of face is equal to recording track width of face, and length is equal to throat height, and becomes a part [a magnetic pole portion]. The 2nd magnetic pole partial layer which the width of face of the portion to which one field contacts the field of another side of the magnetic pole partial layer of the above 1st, and contacts the magnetic pole partial layer of the above 1st is equal to the width of face of the magnetic pole partial layer of the above 1st, and the whole length is larger than the length of the magnetic pole partial layer of the above 1st, and becomes a part [everything but a magnetic pole portion]. The yoke partial layer which is connected to the field of another side of the magnetic pole partial layer of the above 2nd directly or indirectly, and serves as a yoke portion.
[Claim 2] The end face by the side of the medium opposed face of the aforementioned yoke partial layer is the thin film magnetic head according to claim 1 characterized by being arranged in the position distant from the medium opposed face.
[Claim 3] Furthermore, the thin film magnetic head according to claim 1 or 2 characterized by having the insulating layer to which it has been arranged in the side of the magnetic pole partial layer of the above 1st, and flattening of the field by the side of the magnetic pole partial layer of the above 2nd was carried out with the field of another side of the magnetic pole partial layer of the above 1st.
[Claim 4] Some aforementioned thin film coils [at least] are the thin film magnetic head according to claim 1 to 3 characterized by being arranged in the side of the magnetic pole partial layer of the above 1st.
[Claim 5] Furthermore, the thin film magnetic head according to claim 4 characterized by having the coil insulation layer to which some thin film coils [at least] arranged in the side of the magnetic pole partial layer of the above 1st were covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field of another side of the magnetic pole partial layer of the above 2nd.
[Claim 6] The aforementioned thin film coil is the thin film magnetic head according to claim 1 to 3 characterized by having the 1st portion arranged in the side of the magnetic pole partial layer of the above 1st, and the 2nd portion arranged between this 1st portion and the aforementioned yoke partial layer.
[Claim 7] Furthermore, the 1st portion of the thin film coil arranged in the side of the magnetic pole partial layer of the above 1st is covered. It is the thin film magnetic head according to claim 6 which is equipped with the coil insulation layer to which flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field of another side of the magnetic pole partial layer of the above 2nd, and is characterized by arranging the 2nd portion of the aforementioned thin film coil between the aforementioned coil insulation layer and the aforementioned yoke partial layer.
[Claim 8] Aforementioned one magnetic layer is the thin film magnetic head according to claim 1 to 3 characterized by having a connection layer for connecting the magnetic pole partial layer of the above 2nd, and the aforementioned yoke partial layer further.
[Claim 9] The aforementioned thin film coil is the thin film magnetic head according to claim 8 characterized by having the 1st portion arranged in the side of the magnetic pole partial layer of the above 1st, and the 2nd portion

arranged in the side of the aforementioned connection layer.
[Claim 10] The thin film magnetic head according to claim 9 characterized by providing the following. Furthermore, the 1st coil insulation layer to which the 1st portion of the thin film coil arranged in the side of the magnetic pole partial layer of the above 1st was covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field of another side of the magnetic pole partial layer of the above 2nd. The 2nd coil insulation layer to which the 2nd portion of the thin film coil arranged in the side of the aforementioned connection layer was covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field by the side of the yoke partial layer in the aforementioned connection layer.
[Claim 11] The value which the magnetic pole partial layer of the above 1st consisted of high saturation-magnetic-flux-density material, and carried out the division of the magnetic pole partial layer thickness of the above 1st by width of face is the thin film magnetic head according to claim 1 to 10 characterized by being 0.5 or more.
[Claim 12] Furthermore, the thin film magnetic head according to claim 1 to 11 characterized by having the 1st for being arranged so that a magnetic resistance element and the part by the side of a medium opposed face may counter on both sides of the aforementioned magnetic resistance element, and shielding the aforementioned magnetic resistance element, and the 2nd shield layer.
[Claim 13] The medium opposed face which is characterized by providing the following and which counters a record medium, The 1st and 2nd magnetic layers which contain at least one layer including the magnetic pole portion which each other is connected magnetically and counters the aforementioned medium opposed face side mutually, respectively, At least the gap layer prepared between the magnetic pole portion of the 1st magnetic layer of the above and the magnetic pole portion of the 2nd magnetic layer of the above and a part between the above 1st and the 2nd magnetic layer The process which is the manufacture method of the thin film magnetic head equipped with the thin film coil prepared in the state where it insulated to the above 1st and the 2nd magnetic layer, and forms the 1st magnetic layer of the above, At least the process which forms the aforementioned record gap layer on the 1st magnetic layer of the above, the process which forms the 2nd magnetic layer of the above on the aforementioned record gap layer, and a part between the above 1st and the 2nd magnetic layer The process which forms the 2nd magnetic layer of the above including the process which forms the aforementioned thin film coil so that it may be arranged in the state where it insulated to these the 1st and 2nd magnetic layers The process which forms the 1st magnetic pole partial layer from which one field adjoins the aforementioned record gap layer, and the length in a magnetic pole portion is equal to throat height, and becomes a part [a magnetic pole portion], The width of face of the portion to which one field contacts the field of another side of the magnetic pole partial layer of the above 1st, and contacts the magnetic pole partial layer of the above 1st is equal to recording track width of face. And the process which forms the 2nd magnetic pole partial layer to which the whole length is large and becomes a part [everything but a magnetic pole portion] from the length of the magnetic pole partial layer of the above 1st in a magnetic pole portion and the portion in contact with the magnetic pole partial layer of the above 1st, and the 2nd magnetic pole partial layer. The process which **********s the 1st magnetic pole partial layer by using the magnetic pole partial layer of the above 2nd as a mask so that the width of face of the magnetic pole partial layer of the above 1st may become equal to the width of face of the magnetic pole partial layer of the above 2nd. The process which forms the yoke partial layer which is connected to the field of another side of the magnetic pole partial layer of the above 2nd directly or indirectly, and serves as a yoke portion.
[Claim 14] The process which forms the aforementioned yoke partial layer is the manufacture method of the thin film magnetic head according to claim 13 characterized by arranging the end face by the side of the medium opposed face of the aforementioned yoke partial layer in the position distant from the medium opposed face.
[Claim 15] Furthermore, the manufacture method of the thin film magnetic head according to claim 13 or 14 characterized by including the process which forms the insulating layer to which it has been arranged in the side of the magnetic pole partial layer of the above 1st, and flattening of the field by the side of the magnetic pole partial layer of the above 2nd was carried out with the field of another side of the magnetic pole partial layer of the above 1st.
[Claim 16] The process which forms the aforementioned thin film coil is the manufacture method of the thin film magnetic head according to claim 13 to 15 characterized by arranging some aforementioned thin film coils [at least] to the side of the magnetic pole partial layer of the above 1st.
[Claim 17] Furthermore, the manufacture method of the thin film magnetic head according to claim 16 characterized by including the process which forms the coil insulation layer to which some thin film coils [at least] arranged in the side of the magnetic pole partial layer of the above 1st were covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field of another side of the magnetic pole partial layer of the above 2nd.
[Claim 18] The process which forms the aforementioned thin film coil is the manufacture method of the thin film

magnetic head according to claim 13 to 15 characterized by forming the 1st portion arranged in the side of the magnetic pole partial layer of the above 1st, and the 2nd portion arranged between this 1st portion and the aforementioned yoke partial layer.
[Claim 19] Furthermore, the 1st portion of the thin film coil arranged in the side of the magnetic pole partial layer of the above 1st is covered. The process in which the field by the side of the aforementioned yoke partial layer forms the aforementioned thin film coil including the process which forms the coil insulation layer by which flattening was carried out with the field of another side of the magnetic pole partial layer of the above 2nd The manufacture method of the thin film magnetic head according to claim 18 characterized by arranging the 2nd portion of the aforementioned thin film coil between the aforementioned coil insulation layer and the aforementioned yoke partial layer.
[Claim 20] The process which forms the 2nd magnetic layer of the above is the manufacture method of the thin film magnetic head according to claim 13 to 15 characterized by including the process which forms the connection layer for connecting the magnetic pole partial layer of the above 2nd, and the aforementioned yoke partial layer further.
[Claim 21] The process which forms the aforementioned thin film coil is the manufacture method of the thin film magnetic head according to claim 20 characterized by forming the 1st portion arranged in the side of the magnetic pole partial layer of the above 1st, and the 2nd portion arranged in the side of the aforementioned connection layer.
[Claim 22] The manufacture method of the thin film magnetic head according to claim 21 characterized by providing the following. Furthermore, the process which forms the 1st coil insulation layer to which the 1st portion of the thin film coil arranged in the side of the magnetic pole partial layer of the above 1st was covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field of another side of the magnetic pole partial layer of the above 2nd. The process which forms the 2nd coil insulation layer to which the 2nd portion of the thin film coil arranged in the side of the aforementioned connection layer was covered, and flattening of the field by the side of the aforementioned yoke partial layer was carried out with the field by the side of the yoke partial layer in the aforementioned connection layer.
[Claim 23] The manufacture method of the thin film magnetic head according to claim 13 to 22 characterized by **********ing the 1st magnetic pole partial layer using reactive ion etching at the process which **********s the 1st magnetic pole partial layer.
[Claim 24] The manufacture method of the thin film magnetic head according to claim 23 which forms a mask pattern on the 2nd magnetic pole partial layer, and is characterized by **********ing the 2nd magnetic pole partial layer using reactive ion etching, and **********ing the 1st magnetic pole partial layer further using reactive ion etching by using the aforementioned mask pattern and the 2nd magnetic pole partial layer as a mask by using this mask pattern as a mask at the process which **********s the 1st magnetic pole partial layer.
[Claim 25] Furthermore, the manufacture method of the thin film magnetic head according to claim 24 characterized by including the process which **********s in a part of 1st magnetic layer after etching of the magnetic pole partial layer of the above 1st using reactive ion etching by using the aforementioned mask pattern and the 2nd magnetic pole partial layer as a mask.
[Claim 26] The magnetic pole partial layer of the above 2nd is the manufacture method of the thin film magnetic head according to claim 13 to 22 characterized by being formed by the galvanizing method.
[Claim 27] The manufacture method of the thin film magnetic head according to claim 26 characterized by **********ing the 1st magnetic pole partial layer at the process which **********s the magnetic pole partial layer of the above 1st using reactive ion etching by using the magnetic pole partial layer of the above 2nd as a mask.
[Claim 28] Furthermore, the manufacture method of the thin film magnetic head according to claim 27 characterized by including the process which **********s in a part of 1st magnetic layer after etching of the magnetic pole partial layer of the above 1st using reactive ion etching by using the magnetic pole partial layer of the above 2nd as a mask.
[Claim 29] The value which the magnetic pole partial layer of the above 1st consisted of high saturation-magnetic-flux-density material, and carried out the division of the magnetic pole partial layer thickness of the above 1st by width of face is the manufacture method of the thin film magnetic head according to claim 27 or 28 characterized by being 0.5 or more.
[Claim 30] The manufacture method of the claim 27 characterized by using Cl2 or BCl3 as gas in reactive ion etching in the process which **********s the magnetic pole partial layer of the above 1st, or the thin film magnetic head given in 29.
[Claim 31] Reactive ion etching in the process which **********s the magnetic pole partial layer of the above 1st is the manufacture method of the thin film magnetic head according to claim 27 to 30 characterized by being carried out at the temperature within the limits of 50-300 degrees C.
[Claim 32] The manufacture method of the thin film magnetic head according to claim 13 to 31 characterized by providing the following. Furthermore, a magnetic resistance element. The 1st for being arranged so that the part by the

side of a medium opposed face may counter on both sides of the aforementioned magnetic resistance element, and shielding the aforementioned magnetic resistance element, and the 2nd shield layer. The process which forms the 1st and 2nd insulator layers prepared between the aforementioned magnetic resistance element, the above 1st, and the 2nd shield layer.

[Claim 33] Either [at least] the above 1st or the 2nd insulator layer is the manufacture method of the thin film magnetic head according to claim 32 characterized by being formed of a chemical vapor growth.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the thin film magnetic head which has an induction-type MAG sensing element at least, and its manufacture method.
[0002]
[Description of the Prior Art] In recent years, the improvement in a performance of the thin film magnetic head is called for with improvement in the field recording density of a hard disk drive unit. The compound-die thin film magnetic head of the structure which carried out the laminating of the reproducing head which reads as the thin film magnetic head with the recording head which has an induction-type MAG sensing element for writing, and has the magnetic-reluctance (it is hereafter described also as MR (Magneto-resistive).) element of business is used widely.
[0003] By the way, in order to raise recording density among the performances of a recording head, it is necessary to raise the track density in a magnetic-recording medium. It is necessary to realize the recording head of the ** truck structure which narrowed width of face in the pneumatic bearing side of the lower magnetic pole formed in the upper and lower sides on both sides of the record gap layer, and an up magnetic pole from several microns to the submicron size, and for that, in order to attain this, semiconductor processing technology is used.
[0004] Here, with reference to drawing 25 or drawing 28 , an example of the manufacture method of the compound-die thin film magnetic head is explained as an example of the manufacture method of the conventional thin film magnetic head. In addition, in drawing 25 or drawing 28 , (a) shows a cross section perpendicular to a pneumatic bearing side, and (b) shows the cross section parallel to the pneumatic bearing side of a magnetic pole portion.
[0005] By this manufacture method, first, as shown in drawing 25 , the insulating layer 102 which consists of an alumina (aluminum 2O3) is deposited by the thickness of about about 5-10 micrometers on the substrate 101 which consists of ARUTIKKU (aluminum 2O3, TiC). Next, the lower shield layer 103 for the reproducing heads which consists of a magnetic material is formed on an insulating layer 102.
[0006] Next, on the lower shield layer 103, the spatter deposition of the alumina is carried out at the thickness of 100-200nm, and the lower shield gap film 104 as an insulating layer is formed. Next, the MR element 105 for reproduction is formed on the lower shield gap film 104 at the thickness of dozens of nm. Next, the electrode layer 106 of the couple electrically connected to the MR element 105 is formed on the lower shield gap film 104.
[0007] Next, the up shield gap film 107 as an insulating layer is formed on the lower shield gap film 104 and the MR element 105, and the MR element 105 is laid underground in the shield gap film 104,107.
[0008] Next, on the up shield gap film 107, it consists of a magnetic material and the lower [an up shield layer-cum-] magnetic pole layer (it is hereafter described as a lower magnetic pole layer.) 108 used to the both sides of the reproducing head and a recording head is formed at the thickness of about 3 micrometers.
[0009] Next, as shown in drawing 26 , the record gap layer 109 which consists of an insulator layer, for example, an alumina film, is formed on the lower magnetic pole layer 108 at the thickness of 0.2 micrometers. Next, for magnetic-path formation, the record gap layer 109 is **********ed partially and contact hole 109a is formed. Next, the up magnetic pole chip 110 which consists of a magnetic material for recording heads is formed on the record gap layer 109 in a magnetic pole portion at the thickness of 0.5-1.0 micrometers. At this time, the magnetic layer 119 which consists of a magnetic material for magnetic-path formation on contact hole 109a for magnetic-path formation is formed simultaneously.
[0010] Next, as shown in drawing 27 , the record gap layer 109 and the lower magnetic pole layer 108 are **********ed by ion milling by using the up magnetic pole chip 110 as a mask. As shown in drawing 27 (b), the structure where some each side attachment walls of an up magnetic pole portion (up magnetic pole chip 110), the record gap layer 109, and the lower magnetic pole layer 108 were perpendicularly formed in the self-adjustment target

is called trim (Trim) structure.
[0011] Next, the insulating layer 111 which consists of an alumina film is formed in the whole surface at the thickness of about 3 micrometers. Next, it grinds and flattening of this insulating layer 111 is carried out until it reaches the front face of the up magnetic pole chip 110 and a magnetic layer 119.
[0012] Next, the thin film coil 112 of the 1st layer for the recording heads of an induction type which consists of copper (Cu) is formed on the insulating layer 111 by which flattening was carried out. Next, a photoresist layer 113 is formed on an insulating layer 111 and a coil 112 at a predetermined pattern. Next, in order to make the front face of a photoresist layer 113 flat, it heat-treats at predetermined temperature. Next, the thin film coil 114 of the 2nd layer is formed on a photoresist layer 113. Next, a photoresist layer 115 is formed on a photoresist layer 113 and a coil 114 at a predetermined pattern. Next, in order to make the front face of a photoresist layer 115 flat, it heat-treats at predetermined temperature.
[0013] Next, as shown in drawing 28 , the up magnetic pole layer 116 which consists of a magnetic material for recording heads, for example, a permalloy, is formed on the up magnetic pole chip 110, a photoresist layer 113,115, and a magnetic layer 119. Next, the overcoat layer 117 which consists of an alumina is formed on the up magnetic pole layer 116. Finally, a slider is machined, the pneumatic bearing side 118 of the thin film magnetic head containing a recording head and the reproducing head is formed, and the thin film magnetic head is completed.
[0014] Drawing 29 is the plan of the thin film magnetic head shown in drawing 28 . In addition, in this drawing, the overcoat layer 117, other insulating layers, and the insulator layer are omitted.
[0015] In drawing 28 , TH expresses throat height and MR-H expresses MR height. In addition, throat height means the length (height) from the edge by the side of a pneumatic bearing side of the portion which two magnetic pole layers counter through a record gap layer to the edge of an opposite side. Moreover, MR height means the length (height) from the edge by the side of the pneumatic bearing side of MR element to the edge of an opposite side. Moreover, in drawing 28 , P2W express magnetic pole width of face, i.e., recording track width of face. There is an apex angle (Apex Angle) as shown by theta else [, such as throat height and MR height,] in drawing 28 as a factor which determines the performance of the thin film magnetic head. This apex angle says the angle of the straight line which connects the corner of the side by the side of the magnetic pole in the coil portion (henceforth the apex section) which was covered by the photoresist layer 113,115 and rose in the shape of a mountain, and the upper surface of an insulating layer 111 to make.
[0016]
[Problem(s) to be Solved by the Invention] In order to raise the performance of the thin film magnetic head, it is important to form correctly the throat height TH as shown in drawing 28 , MR height MR-H, the apex angle theta, and recording track width-of-face P2W.
[0017] In order to enable high surface density record especially in recent years (i.e., in order to form the recording head of ** truck structure), the submicron size of 1.0 micrometers or less is demanded of width-of-recording-track P2W. Therefore, the technology of processing an up magnetic pole into a submicron size using semiconductor processing technology is needed.
[0018] Here, it poses a problem that it is difficult to form minutely the up magnetic pole layer formed on the apex section.
[0019] By the way, as a method of forming an up magnetic pole layer, as shown in JP,7-262519,A, the frame galvanizing method is used, for example. When forming an up magnetic pole layer using the frame galvanizing method, on the whole, the thin electrode layer which consists of a permalloy is first formed by sputtering on the apex section. Next, on it, a photoresist is applied, patterning is carried out according to a photolithography process, and the frame for plating (outer frame) is formed. And an up magnetic pole layer is formed by the galvanizing method by using as a seed layer the electrode layer formed previously.
[0020] However, there is the difference of elevation 7-10 micrometers or more in the apex section and other portions, for example. On this apex section, a photoresist is applied by the thickness of 3-4 micrometers. Supposing the thickness of the photoresist on the apex section is at least 3-micrometer or more need, since the photoresist with a fluidity gathers in the lower one, in the lower part of the apex section, a photoresist film with a thickness of 8-10 micrometers or more will be formed, for example.
[0021] In order to realize recording track width of face of a submicron size as mentioned above, it is necessary to form the frame pattern of the width of face of a submicron size with a photoresist film. Therefore, you have to form a pattern with a detailed submicron size on the apex section with a photoresist film with the thickness of 8-10 micrometers or more. However, it was very difficult on the manufacturing process to form the photoresist pattern of such thick thickness by ** pattern width of face.
[0022] And at the time of exposure of a photolithography, the light for exposure reflects by the ground electrode layer

as a seed layer, a photoresist exposes, collapse of a photoresist pattern etc. arises and a sharp and exact photoresist pattern is no longer obtained by this reflected light.
[0023] Thus, when magnetic pole width of face became a submicron size conventionally, there was a trouble that it became difficult to form an up magnetic layer with a sufficient precision.
[0024] As drawing 26 of the above-mentioned conventional example or the process of drawing 28 also showed, after forming the width of recording track 1.0 micrometers or less from such a thing with the up magnetic pole chip 110 effective in formation of the ** truck of a recording head, the method of forming the up magnetic pole layer 116 used as the yoke portion connected with this up magnetic pole chip 110 is also adopted (refer to JP,62-245509,A and JP,60-10409,A). Thus, it becomes possible by dividing the usual up magnetic pole layer into the up magnetic pole layer 116 used as the up magnetic pole chip 110 and a yoke portion to form somewhat minutely the up magnetic pole chip 110 which determines recording track width of face on the flat field on the record gap layer 109.
[0025] However, there were the following troubles of (1) or (3) also by the thin film magnetic head of structure as shown in drawing 28 .
[0026] (1) In the thin film magnetic head shown in drawing 28 , the up magnetic pole chip 110 has prescribed recording track width of face and throat height. Therefore, in this thin film magnetic head, it becomes difficult for a pattern edge to be roundish and for recording track width of face to form the up magnetic pole chip 110 with a sufficient precision, since [if set especially to 0.5 micrometers or less] the size of the up magnetic pole chip 110 will become very small, microscopic ** and. Therefore, in the thin film magnetic head of structure as shown in drawing 28 , when recording track width of face became microscopic **, there was a trouble that it became difficult to specify recording track width of face and throat height with a sufficient precision.
[0027] (2) In the thin film magnetic head shown in drawing 28 , since recording track width of face is prescribed by the up magnetic pole chip 110, it can be said that it is not necessary to process the up magnetic pole layer 116 into about 110 up magnetic pole chip minutely. Still, if recording track width of face is set to microscopic **, especially 0.5 micrometers or less, also in the up magnetic pole layer 116, the process tolerance of submicron width of face will be required. However, in the thin film magnetic head shown in drawing 28 , the up magnetic pole layer 116 was difficult to form the up magnetic pole layer 116 minutely for the above-mentioned reason from being formed on the apex section. Moreover, since it needed to connect magnetically to the up magnetic pole chip 110 with narrow width of face, the up magnetic pole layer 116 needed to be formed in width of face larger than the up magnetic pole chip 110. From these reasons, the up magnetic pole layer 116 was formed in width of face larger than the up magnetic pole chip 110 by the thin film magnetic head shown in drawing 28 . Moreover, the apical surface of the up magnetic pole layer 116 is exposed to a pneumatic bearing side. Therefore, in the thin film magnetic head shown in drawing 28 , the up magnetic pole layer 116 side also had the trouble which writing is performed and writes data also in fields other than the field which should originally be recorded to a record medium that the so-called side light was generated. In order that such a trouble may raise the performance of a recording head, when a coil is formed in two-layer or three layers, compared with the case where a coil is formed in one layer, the height of the apex section becomes high and it becomes more remarkable.
[0028] (3) Moreover, in the thin film magnetic head shown in drawing 28 , in order that the cross section of a magnetic path might decrease rapidly in the contact portion of the up magnetic pole layer 116 and the up magnetic pole chip 110, there was a trouble of it becoming impossible to use efficiently for record the magnetomotive force which the saturation of magnetic flux produced in this portion, and was generated with the thin film coil 112,114.
[0029] Moreover, in the conventional thin film magnetic head, there was a trouble that it was difficult to shorten magnetic-path length (Yoke Length). That is, although the recording head which could realize the short head of magnetic-path length and was excellent in especially the RF property could be formed so that the coil pitch was small, when a coil pitch was made small infinite, the distance from a throat height zero position (position of the edge by the side of the pneumatic bearing side of the insulating layer which determines throat height) to the periphery edge of a coil had become the big factor which bars shortening magnetic-path length. Since magnetic-path length can do the two-layer coil short rather than the coil of one layer, he has adopted the two-layer coil in the recording head for many RFs. However, by the conventional magnetic head, after forming the coil of the 1st layer, in order to form the insulator layer between coils, the photoresist film is formed by the thickness of about 2 micrometers. Therefore, the small apex roundish [wore] is formed in the periphery edge of the coil of the 1st layer. Next, although the coil of a two-layer eye is formed on it, since etching of the seed layer of a coil cannot be performed but a coil short-circuits by the ramp of the apex section in that case, it is necessary to form the coil of a two-layer eye in a flat part.
[0030] When follow, for example, thickness of a coil is set to 2-3 micrometers, thickness of the insulator layer between coils is set to 2 micrometers and an apex angle is made into 45 degrees - 55 degrees, as magnetic-path length Double precision of the 3-4-micrometer distance which is the distance of a up to [from the periphery edge of a coil] near the

throat height zero position in addition to the length of the portion corresponding to a coil (3-4 micrometers also of distance from the contact section of an up magnetic pole layer and a lower magnetic pole layer to a coil inner circumference edge are also required.) 6-8 micrometers is required. Length other than the portion corresponding to this coil had become the factor which bars reduction of magnetic-path length.

[0031] Here, the case where the 11-volume coil whose space the line breadth of a coil is 1.2 micrometers and is 0.8 micrometers is formed by two-layer is considered. In this case, as shown in drawing 28 , when it is made the 1st layer into six volumes and a two-layer eye is made into five volumes, the length of the portion corresponding to the coil 112 of the 1st layer is 11.2 micrometers among magnetic-path length. A length of a total of six -8 micrometers is needed for magnetic-path length as a distance to the edge of the photoresist layer 113 for insulating the coil 112 of the 1st layer from the periphery edge and inner circumference edge of a coil 112 of the 1st layer. Therefore, magnetic-path length is set to 17.2-19.2 micrometers. Moreover, if a 11-volume coil is formed by one layer, magnetic-path length is set to 27.2-29.2 micrometers. In addition, as the sign L0 showed magnetic-path length in drawing 28 , the length of the portion except the magnetic pole portion of the magnetic pole layers and the contact portion expresses with this application. Thus, conventionally, reduction of magnetic-path length is difficult and this had barred the improvement of a RF property.

[0032] this invention was made in view of this trouble, and the 1st purpose is to offer the thin film magnetic head which enabled it to prevent the saturation of the magnetic flux in the middle of a magnetic path, and its manufacture method while being able to specify the width of recording track and throat height with a sufficient precision, even when the width of recording track of an induction-type MAG sensing element is made small.

[0033] The 2nd purpose of this invention is to offer the thin film magnetic head which enabled it to prevent the writing of the data to fields other than the field which should be recorded, and its manufacture method in addition to the 1st purpose of the above.

[0034] The 3rd purpose of this invention is to offer the thin film magnetic head which enabled reduction of magnetic-path length, and its manufacture method in addition to the 1st purpose of the above.

[0035]

[Means for Solving the Problem] The 1st and 2nd magnetic layers which contain at least one layer including the magnetic pole portion which the thin film magnetic head of this invention is magnetically connected with the medium opposed face which counters a record medium mutually, and counters a medium opposed face side mutually, respectively, At least the gap layer prepared between the magnetic pole portion of the 1st magnetic layer and the magnetic pole portion of the 2nd magnetic layer and a part between the 1st and 2nd magnetic layers It is the thin film magnetic head equipped with the thin film coil prepared in the state where it insulated to the 1st and 2nd magnetic layers. The 1st magnetic pole partial layer which one field adjoins [one magnetic layer] a record gap layer, width of face is equal to recording track width of face, and length is equal to throat height, and becomes a part [a magnetic pole portion], The width of face of the portion to which one field contacts the field of another side of the 1st magnetic pole partial layer, and contacts the 1st magnetic pole partial layer is equal to the width of face of the 1st magnetic pole partial layer. And the whole length is connected directly [it is larger than the length of the 1st magnetic pole partial layer, and / the field of another side of the 2nd magnetic pole partial layer which becomes a part / everything but a magnetic pole portion /, and the 2nd magnetic pole partial layer], or indirectly, and it has a yoke partial layer used as a yoke portion.

[0036] In the thin film magnetic head of this invention, the 1st magnetic pole partial layer of one magnetic layer has length equal to throat height. Therefore, throat height is prescribed by the 1st magnetic pole partial layer. Moreover, in this thin film magnetic head, the 1st magnetic pole partial layer of one magnetic layer and the 2nd magnetic pole partial layer have width of face equal to recording track width of face. Therefore, recording track width of face is prescribed by the 1st magnetic pole partial layer and the 2nd magnetic pole partial layer. It connects with the 2nd magnetic pole partial layer directly [a yoke partial layer] or indirectly.

[0037] The medium opposed face to which the manufacture method of the thin film magnetic head of this invention counters a record medium, The 1st and 2nd magnetic layers which contain at least one layer including the magnetic pole portion which each other is connected magnetically and counters a medium opposed face side mutually, respectively, At least the gap layer prepared between the magnetic pole portion of the 1st magnetic layer and the magnetic pole portion of the 2nd magnetic layer and a part between the 1st and 2nd magnetic layers The process which is the manufacture method of the thin film magnetic head equipped with the thin film coil prepared in the state where it insulated to the 1st and 2nd magnetic layers, and forms the 1st magnetic layer, At least the process which forms a record gap layer on the 1st magnetic layer, the process which forms the 2nd magnetic layer on a record gap layer, and a part between the 1st and 2nd magnetic layers So that it may be arranged in the state where it insulated to these the 1st and 2nd magnetic layers The process in which the process which forms the 2nd magnetic layer forms the 1st magnetic

pole partial layer from which one field adjoins a record gap layer, and the length in a magnetic pole portion is equal to throat height, and becomes a part [a magnetic pole portion] including the process which forms a thin film coil, The width of face of the portion to which one field contacts the field of another side of the 1st magnetic pole partial layer, and contacts the 1st magnetic pole partial layer is equal to recording track width of face. And it sets into the process which forms the 2nd magnetic pole partial layer to which the whole length is large and becomes a part [everything but a magnetic pole portion] from the length of the 1st magnetic pole partial layer in a magnetic pole portion, and the portion in contact with the 1st magnetic pole partial layer and the 2nd magnetic pole partial layer. So that the width of face of the 1st magnetic pole partial layer may become equal to the width of face of the 2nd magnetic pole partial layer It connects with the process which **********s the 1st magnetic pole partial layer by using the 2nd magnetic pole partial layer as a mask, and the field of another side of the 2nd magnetic pole partial layer directly or indirectly, and the process which forms the yoke partial layer used as a yoke portion is included.

[0038] Throat height is prescribed by the 1st magnetic pole partial layer of the 2nd magnetic layer by the manufacture method of the thin film magnetic head of this invention. Moreover, let width of face of the 1st magnetic pole partial layer be width of face equal to the 2nd width of face, i.e., recording track width of face, of a magnetic pole partial layer by this manufacture method by **********ing the 1st magnetic pole partial layer by using the 2nd magnetic pole partial layer of the 2nd magnetic layer as a mask. Therefore, recording track width of face is prescribed by the 1st magnetic pole partial layer and the 2nd magnetic pole partial layer. It connects with the 2nd magnetic pole partial layer directly [a yoke partial layer] or indirectly.

[0039] Moreover, by the thin film magnetic head or its manufacture method of this invention, you may arrange the end face by the side of the medium opposed face of a yoke partial layer in the position distant from the medium opposed face.

[0040] Moreover, by the thin film magnetic head or its manufacture method of this invention, further, it is arranged in the side of the 1st magnetic pole partial layer, and the insulating layer to which flattening of the field by the side of the 2nd magnetic pole partial layer was carried out with the field of another side of the 1st magnetic pole partial layer may be prepared.

[0041] Moreover, by the thin film magnetic head or its manufacture method of this invention, you may arrange some thin film coils [at least] to the side of the 1st magnetic pole partial layer. In this case, some thin film coils [at least] arranged in the side of the 1st magnetic pole partial layer may be covered further, and the coil insulation layer to which flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer may be prepared.

[0042] Moreover, you may make it a thin film coil have the 1st portion arranged in the side of the 1st magnetic pole partial layer, and the 2nd portion arranged between this 1st portion and a yoke partial layer by the thin film magnetic head or its manufacture method of this invention. In this case, the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer may be covered further, the coil insulation layer to which flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer may be prepared, and the 2nd portion of a thin film coil may be arranged between a coil insulation layer and a yoke partial layer.

[0043] Moreover, you may make it one magnetic layer have a connection layer for connecting the 2nd magnetic pole partial layer and yoke partial layer further by the thin film magnetic head or its manufacture method of this invention. In this case, you may make it a thin film coil have the 1st portion arranged in the side of the 1st magnetic pole partial layer, and the 2nd portion arranged in the side of a connection layer. thus, when a thin film coil has the 1st portion and 2nd portion Furthermore, the 1st coil insulation layer to which the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer was covered, and flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer, The 2nd portion of the thin film coil arranged in the side of a connection layer may be covered, and the 2nd coil insulation layer to which flattening of the field by the side of a yoke partial layer was carried out with the field by the side of the yoke partial layer in a connection layer may be prepared.

[0044] Moreover, in the thin film magnetic head of this invention, the value which the 1st magnetic pole partial layer consisted of high saturation-magnetic-flux-density material, and carried out the division of the 1st magnetic pole partial layer thickness by width of face may be 0.5 or more. In addition, in this invention, as for high saturation-magnetic-flux-density material, saturation magnetic flux density says the magnetic material beyond 1.4T.

[0045] Moreover, further, the thin film magnetic head of this invention has been arranged so that a magnetic resistance element and the part by the side of a medium opposed face may counter on both sides of a magnetic resistance element, and it may be equipped with the 1st for shielding a magnetic resistance element, and the 2nd shield layer.

[0046] Moreover, in the manufacture method of the thin film magnetic head of this invention, you may **********

the 1st magnetic pole partial layer at the process which **********s the 1st magnetic pole partial layer using reactive ion etching. In this case, at the process which **********s the 1st magnetic pole partial layer, a mask pattern may be formed on the 2nd magnetic pole partial layer, the 2nd magnetic pole partial layer may be **********ed using reactive ion etching by using this mask pattern as a mask, and you may ********** the 1st magnetic pole partial layer further using reactive ion etching by using a mask pattern and the 2nd magnetic pole partial layer as a mask. Moreover, in the manufacture method of the thin film magnetic head of this invention, after **********ing the 1st magnetic pole partial layer using reactive ion etching by using a mask pattern and the 2nd magnetic pole partial layer as a mask, you may ********** in a part of 1st magnetic layer using reactive ion etching by using a mask pattern and the 2nd magnetic pole partial layer as a mask.

[0047] Moreover, in the manufacture method of the thin film magnetic head of this invention, the 2nd magnetic pole partial layer may be formed by the galvanizing method. In this case, at the process which **********s the 1st magnetic pole partial layer, you may ********** the 1st magnetic pole partial layer using reactive ion etching by using the 2nd magnetic pole partial layer as a mask. Moreover, in the manufacture method of the thin film magnetic head of this invention, after **********ing the 1st magnetic pole partial layer using reactive ion etching by using the 2nd magnetic pole partial layer as a mask, you may ********** in a part of 1st magnetic layer using reactive ion etching by using the 2nd magnetic pole partial layer as a mask.

[0048] When **********ing the 1st magnetic pole partial layer using reactive ion etching as mentioned above, you may make it the value which carried out the division of the 1st magnetic pole partial layer thickness by width of face by the 1st magnetic pole partial layer consisting of high saturation-magnetic-flux-density material be 0.5 or more. Moreover, in reactive ion etching in the process which **********s the 1st magnetic pole partial layer, you may use Cl2 or BCl3 as gas. Moreover, reactive ion etching in the process which **********s the 1st magnetic pole partial layer may be made to be performed at the temperature within the limits of 50-300 degrees C.

[0049] Further, the manufacture method of the thin film magnetic head of this invention is arranged so that a magnetic resistance element and the part by the side of a medium opposed face may counter on both sides of a magnetic resistance element, and it may include the process which forms the 1st and 2nd insulator layers prepared between the 1st for shielding a magnetic resistance element and the 2nd shield layer, and the magnetic resistance element, the 1st, and 2nd shield layers. In this case, you may form at least one side of the 1st and 2nd insulator layers by the chemical vapor growth.

[0050]

[Embodiments of the Invention] Hereafter, the form of operation of this invention is explained in detail with reference to a drawing.

[the form of the 1st operation] -- with reference to drawing 1 or drawing 10 , the thin film magnetic head concerning the form of operation of the 1st of this invention and its manufacture method are explained first In addition, in drawing 1 or drawing 8 , (a) shows a cross section perpendicular to a pneumatic bearing side, and (b) shows the cross section parallel to the pneumatic bearing side of a magnetic pole portion.

[0051] By the manufacture method of the thin film magnetic head concerning the form of this operation, first, as shown in drawing 1 , the insulating layer 2 which consists of an alumina (aluminum 2O3) is deposited by the thickness of about 5 micrometers on the substrate 1 which consists of ARUTIKKU (aluminum 2O3, TiC). Next, the lower shield layer 3 for the reproducing heads which consists of a magnetic material, for example, a permalloy, is formed on an insulating layer 2 at the thickness of about 3 micrometers. The lower shield layer 3 uses for example, a photoresist film as a mask, and forms it alternatively on an insulating layer 2 by the galvanizing method. Next, although not illustrated, it grinds until it forms in the thickness of 4-5 micrometers the insulating layer which consists of an alumina, for example, the lower shield layer 3 is exposed to the whole with CMP (chemical machinery polish), and flattening processing of the front face is carried out.

[0052] Next, as shown in drawing 2 , the lower shield gap film 4 as an insulator layer is formed on the lower shield layer 3 at the thickness of about 20-40nm. Next, the MR element 5 for reproduction is formed on the lower shield gap film 4 at the thickness of dozens of nm. The MR element 5 forms MR film formed by the spatter by **********ing alternatively. In addition, the element using the magnetosensitive film in which the magnetoresistance effects, such as the AMR element, a GMR element, or a TMR (tunnel magnetoresistance effect) element, are shown can be used for the MR element 5. Next, the electrode layer 6 of the couple electrically connected to the MR element 5 is formed on the lower shield gap film 4 at the thickness of dozens of nm. Next, the up shield gap film 7 as an insulator layer is formed on the lower shield gap film 4 and the MR element 5 at the thickness of about 20-40nm, and the MR element 5 is laid underground in the shield gap film 4 and 7. As an insulating material used for the shield gap films 4 and 7, there are an alumina, alumimium nitride, diamond-like carbon (DLC), etc. Moreover, the shield gap films 4 and 7 may be formed by the spatter, and may be formed, for example by the chemical vapor-growth (CVD) method using a

trimethylaluminum (aluminum3 (CH3)), H2O, etc. If CVD is used, it will become it is thin, and is precise and possible to form the few shield gap films 4 and 7 of a pinhole.

[0053] Next, on the up shield gap film 7, it consists of a magnetic material and the lower [an up shield layer-cum-] magnetic pole layer (it is hereafter described as a lower magnetic pole layer.) 8 used to the both sides of the reproducing head and a recording head is alternatively formed by the thickness of about 2.5-3.5 micrometers.

[0054] Next, as shown in drawing 3 , the record gap layer 9 which consists of an insulating material is formed at the thickness of 0.2-0.3 micrometers on the lower magnetic pole layer 8 and the up shield gap film 7. Generally as an insulating material used for the record gap layer 9, there are an alumina, alumimium nitride, silicon oxide system material, silicon nitride system material, diamond-like carbon (DLC), etc.

[0055] Next, for magnetic-path formation, in the position near the edge of an opposite side (it sets to drawing 3 (a) and is right-hand side), the record gap layer 9 is **********ed partially and contact hole 9a is formed in the pneumatic bearing side 30 of the lower magnetic pole layer 8.

[0056] Next, in the position near [by the side of the pneumatic bearing side 30 of the record gap layer 9] the edge, 1st magnetic pole partial layer 10a which consists of a magnetic material and becomes a part [the magnetic pole portion of an up magnetic pole layer] on the record gap layer 9 is formed in the thickness of about 0.5-1.0 micrometers. At this time, the magnetic layer 11 which consists of a magnetic material for magnetic-path formation on contact hole 9a for magnetic-path formation is simultaneously formed in the thickness of about 0.5-1.0 micrometers. It is formed so that the width of face (size of the longitudinal direction in drawing 3 (b)) may become larger than recording track width of face at this time as for 1st magnetic pole partial layer 10a. Moreover, the length (size of the longitudinal direction in drawing 3 (a)) of 1st magnetic pole partial layer 10a in a magnetic pole portion is equal to throat height.

[0057] Next, the insulating layer 12 which consists of an alumina is formed in the whole at the thickness of 4-5 micrometers. Next, for example by CMP, an insulating layer 12 is ground and flattening processing of the front face is carried out until 1st magnetic pole partial layer 10a and a magnetic layer 11 are exposed. By this polish, the thickness of the insulating layer 12 in the portion on the lower magnetic pole layer 8 is set to 0.5-0.8 micrometers. In drawing 3 (a), the boundary position of 1st magnetic pole partial layer 10a and an insulating layer 12 turns into a throat height zero position.

[0058] Next, as shown in drawing 4 , 2nd magnetic pole partial layer 10b which consists of a magnetic material and becomes a part [everything but the magnetic pole portion of an up magnetic pole layer] on 1st magnetic pole partial layer 10a is formed in the thickness of about 2.5-3.5 micrometers. At this time, a magnetic layer 13 is simultaneously formed on a magnetic layer 11 at the thickness of about 2.5-3.5 micrometers. 2nd magnetic pole partial layer 10b has the width of face of the portion in contact with 1st magnetic pole partial layer 10a equal to recording track width of face, and the whole length is larger than the length of 1st magnetic pole partial layer 10a in a magnetic pole portion.

[0059] 1st magnetic pole partial layer 10a and 2nd magnetic pole partial layer 10b NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material are used. It may form in a predetermined pattern by the galvanizing method, and using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material, after a spatter, it **********s alternatively and you may form in a predetermined pattern by ion milling etc. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material.

[0060] Drawing 9 is a plan corresponding to drawing 4 . In addition, in this drawing, the record gap layer 9 and the insulating layer 12 are omitted. Although 1st magnetic pole partial layer 10a is arranged crosswise widely, the width of face of 1st magnetic pole partial layer 10a should be just larger than recording track width of face in this drawing.

[0061] Next, as shown in drawing 5 , 1st magnetic pole partial layer 10a and an insulating layer 12 are **********ed by the ion milling for example, using argon system gas by using 2nd magnetic pole partial layer 10b as a mask. Thereby, in the portion in contact with 2nd magnetic pole partial layer 10b, the width of face of 1st magnetic pole partial layer 10a becomes equal to the width of face of the 2nd magnetic pole partial layer, i.e., recording track width of face.

[0062] Next, the record gap layer 9 is alternatively **********ed by dry etching by using 1st magnetic pole partial layer 10a and 2nd magnetic pole partial layer 10b as a mask. Reactive ion etching (it is hereafter described as RIE.) which used gas, such as chlorine-based gas of BCl2 and Cl2 grade and fluorine system gas of CF4 and SF6 grade, is used for the dry etching at this time. Next, it considers as trim structure as **********s about about 0.3-0.6 micrometers alternatively and showed the lower magnetic pole layer 8 to drawing 5 (b), for example by the ion milling using argon system gas. According to this trim structure, the increase in the effective width of recording track by the breadth of the magnetic flux generated at the time of the writing of a ** truck can be prevented. In addition, in the case of etching of the record gap layer 9 and the lower magnetic pole layer 8, after forming the photo mask for trims which is not illustrated on portions other than the field which should **********, you may be made to etch.

[0063] In addition, you may make 1st magnetic pole partial layer 10a ********** by the 1st method explained below or the 2nd method in the gestalt of this operation using RIE.
[0064] The 1st method is the method of using an alumina etc., forming a mask pattern and **********ing 2nd magnetic pole partial layer 10b and 1st magnetic pole partial layer 10a by using this mask pattern as a mask using RIE on 2nd magnetic pole partial layer 10b. By the 1st method, patterning of the 2nd magnetic pole partial layer 10b is first carried out by RIE by using a mask pattern as a mask, and patterning of the 1st magnetic pole partial layer 10a is further carried out by RIE by using as a mask a mask pattern and 2nd magnetic pole partial layer 10b by which patterning was carried out. Therefore, this 1st method is also included in the manufacture method of the thin film magnetic head of this invention. In the 1st method, by using the above-mentioned mask pattern as a mask, further, it **********s using RIE in a part of record gap layer 9 and lower magnetic pole layer 8, and trim structure may be formed. In the 1st method, 1st magnetic pole partial layer 10a and 2nd magnetic pole partial layer 10b may be formed by the galvanizing method using NiFe etc., and may be formed by carrying out sputtering of the high saturation-magnetic-flux-density material, such as FeN and CoFe.
[0065] The 2nd method is the method of forming 2nd magnetic pole partial layer 10b in a predetermined pattern by the galvanizing method using NiFe etc., and **********ing 1st magnetic pole partial layer 10a using RIE by using this 2nd magnetic pole partial layer 10b as a mask. In the 2nd method, by using 2nd magnetic pole partial layer 10b as a mask, further, it **********s using RIE in a part of record gap layer 9 and lower magnetic pole layer 8, and trim structure may be formed. In the 2nd method, 1st magnetic pole partial layer 10a may be formed by the galvanizing method using NiFe etc., and may be formed by carrying out sputtering of the high saturation-magnetic-flux-density material, such as FeN and CoFe.
[0066] In RIE in the 2nd method, it is desirable to use Cl2 or BCl3 as gas. Moreover, as for RIE in the 2nd method, it is desirable to carry out at the temperature within the limits of 50-300 degrees C. When 2nd magnetic pole partial layer 10b is formed by performing RIE at such high temperature using NiFe, it can prevent that nickel molecule re-adheres in the case of RIE.
[0067] According to the 2nd method, by forming 2nd magnetic pole partial layer 10b by the galvanizing method 2nd magnetic pole partial layer 10b can be formed so that the width of recording track may be set to 0.3 micrometers or less, and the width of face of 1st magnetic pole partial layer 10a can also be formed in 0.3 micrometers or less by **********ing 1st magnetic pole partial layer 10a by using this 2nd magnetic pole partial layer 10b as a mask.
[0068] Moreover, according to the 2nd method, by **********ing 1st magnetic pole partial layer 10a by RIE by using 2nd magnetic pole partial layer 10b as a mask, the pattern of 2nd magnetic pole partial layer 10b does not collapse, for example, 1st magnetic pole partial layer 10a with a width of face of 0.3 micrometers or less can be formed correctly.
[0069] Hereafter, 1st magnetic pole partial layer 10a is **********ed using RIE by using as a mask 2nd magnetic pole partial layer 10b which formed 1st magnetic pole partial layer 10a, and was formed by the galvanizing method, and by carrying out sputtering of the high saturation-magnetic-flux-density material describes the case where 1st magnetic pole partial layer 10a is formed in a predetermined pattern. Drawing 11 shows an example of the experimental result which asked for the relation between value T/P2W which carried out the division of the thickness T of 1st magnetic pole partial layer 10a in this case by the width of face of 1st magnetic pole partial layer 10a after patterning, recording track width-of-face P2W [i.e.,], and the over-writing property which is a property in the case of carrying out overwrite. If T/P2W are made or more into 0.5, an over-writing property will be set to 30dB or more, and this drawing shows that it is desirable.
[0070] Next, as shown in drawing 6 , the insulator layer 15 which consists of an alumina in order to insulate the thin film coil and the lower magnetic pole layer 8 which are mentioned later is formed in the whole at the thickness of about 0.3-0.5 micrometers. Next, the thin film coil 16 which consists of copper (Cu) is formed for example, by the frame galvanizing method on an insulator layer 15 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The thin film coil 16 is formed so that it may be wound focusing on magnetic layers 11 and 13, and the part is arranged in the side of 1st magnetic pole partial layer 10a. In addition, in drawing 6 (a), sign 16a shows the connection for connecting with the conductive layer (lead) which mentions the thin film coil 16 later.
[0071] Next, as shown in drawing 7 , the coil insulation layer 17 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 17 is ground and flattening processing of the front face is carried out until 2nd magnetic pole partial layer 10b and a magnetic layer 13 are exposed. Although the thin film coil 16 is not exposed, you may make it exposed [the thin film coil 16] by drawing 7 (a) here. When it is made exposed [the thin film coil 16], a wrap insulator layer is formed for the thin film coil 16.
[0072] Next, as shown in drawing 8 , on connection 16a, the coil insulation layer 17 is **********ed partially and a contact hole is formed. Next, the yoke partial layer 18 used as the yoke portion of an up magnetic pole layer is formed

at the thickness of about 2.0-3.0 micrometers on 2nd magnetic pole partial layer 10b, the coil insulation layer 17, and a magnetic layer 13. At this time, the conductive layer 19 connected to connection 16a is simultaneously formed in the thickness of about 2.0-3.0 micrometers. Using NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material, the yoke partial layer 18 may be formed in a predetermined pattern by the galvanizing method, using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material, **********s alternatively and may be formed in a predetermined pattern by ion milling etc. after a spatter. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material. Moreover, it is good also as structure which laid the insulator layer of an inorganic system, and magnetic layers, such as a permalloy, on top of many layers for the yoke partial layer 18 because of an improvement of a RF property.

[0073] Moreover, the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 18 is arranged in the position near the throat height zero position especially with the form of the position distant from the pneumatic bearing side 30 only 0.5-1.0 micrometers, and this operation.

[0074] Next, the overcoat layer 20 which consists of an alumina is formed in the thickness of 20-40 micrometers, flattening of the front face is carried out to the whole, and the pad for electrodes which is not illustrated is formed on it. Finally, polish processing of a slider is performed, the pneumatic bearing side 30 of the thin film magnetic head containing a recording head and the reproducing head is formed, and the thin film magnetic head concerning the form of this operation is completed.

[0075] With the form of this operation, the lower magnetic pole layer 8 is equivalent to the 1st magnetic layer in this invention, and the up magnetic pole layer which consists of 1st magnetic pole partial layer 10a, 2nd magnetic pole partial layer 10b, magnetic layers 11 and 13, and a yoke partial layer 18 is equivalent to the 2nd magnetic layer in this invention. Moreover, the lower shield layer 3 is equivalent to the 1st shield layer in this invention. Moreover, since the lower magnetic pole layer 8 serves as the up shield layer, it is equivalent also to the 2nd shield layer in this invention.

[0076] Drawing 10 is the plan of the thin film magnetic head concerning the gestalt of this operation. In addition, in this drawing, the overcoat layer 20, other insulating layers, and the insulator layer are omitted. In drawing 10 , the sign TH0 shows the throat height zero position.

[0077] As explained above, the thin film magnetic head concerning the gestalt of this operation is equipped with the reproducing head and the recording head (induction-type MAG sensing element). The reproducing head is arranged so that the part by the side of the MR element 5 and the medium opposed face (pneumatic bearing side 30) which counters a record medium may counter on both sides of the MR element 5, and it has the lower shield layer 3 and up shield layer (lower magnetic pole layer 8) for shielding the MR element 5.

[0078] The recording head of each other is connected magnetically and the magnetic pole portion which counters a medium opposed face side mutually is included. The lower magnetic pole layer 8 and up magnetic pole layer (1st magnetic pole partial layer 10a, 2nd magnetic pole partial layer 10b, the magnetic layers 11 and 13, and yoke partial layer 18) which contain at least one layer, respectively, It has the record gap layer 9 prepared between each magnetic pole portion of these two magnetic pole layers, and the thin film coil 16 with which the part [at least] was arranged in the state where it insulated to two magnetic pole layers between these two magnetic pole layers.

[0079] 1st magnetic pole partial layer 10a which one field adjoins the record gap layer 9, an up magnetic pole layer has width of face equal to recording track width of face, and length is equal to throat height, and becomes a part [a magnetic pole portion] with the gestalt of this operation, The width of face of the portion to which one field contacts the field of another side of 1st magnetic pole partial layer 10a, and contacts 1st magnetic pole partial layer 10a is equal to the width of face of 1st magnetic pole partial layer 10a, i.e., recording track width of face. And the whole length is larger than the length of 1st magnetic pole partial layer 10a, and it connects with 2nd magnetic pole partial layer 10b which becomes a part [everything but a magnetic pole portion] in the field of another side of the 2nd magnetic pole partial layer, and has the yoke partial layer 18 used as a yoke portion. Therefore, with the gestalt of this operation, throat height is prescribed by 1st magnetic pole partial layer 10a of an up magnetic pole layer, and recording track width of face is prescribed by 1st magnetic pole partial layer 10a of an up magnetic pole layer, and 2nd magnetic pole partial layer 10b.

[0080] With the gestalt of this operation, although it finally has length equal to throat height, and width of face equal to recording track width of face, 1st magnetic pole partial layer 10a is formed so that it may have larger width of face than recording track width of face in the beginning. And let width of face of 1st magnetic pole partial layer 10a be width of face equal to recording track width of face by **********ing 1st magnetic pole partial layer 10a by using this 2nd magnetic pole partial layer 10b as a mask after forming 2nd magnetic pole partial layer 10b which has width of face equal to recording track width of face. thus, 1st magnetic pole partial layer 10a can be formed with a sufficient precision, without a pattern edge being roundish compared with the case where the magnetic pole portion which has

length equal to width of face equal to recording track width of face and throat height is formed, since according to the gestalt of this operation magnetic pole partial layer 10a of introduction 1st can be formed so that it may have larger width of face than recording track width of face and it begins And according to the gestalt of this operation, since 1st magnetic pole partial layer 10a can be formed on a flat field, 1st magnetic pole partial layer 10a can be formed with a sufficient precision also from this point. Therefore, according to the gestalt of this operation, even when the width of recording track is made small, throat height can be specified with a sufficient precision.

[0081] Moreover, with the gestalt of this operation, 2nd magnetic pole partial layer 10b is formed so that the width of face of the portion in contact with 1st magnetic pole partial layer 10a may become [the whole length] larger than the length of 1st magnetic pole partial layer 10a equally to recording track width of face. Therefore, according to the gestalt of this operation, compared with the case where the magnetic pole portion which has length equal to width of face equal to recording track width of face and throat height is formed, 2nd magnetic pole partial layer 10b can be formed with a sufficient precision. Moreover, with the gestalt of this operation, since the upper surface can form 2nd magnetic pole partial layer 10b on 1st magnetic pole partial layer 10a by which flattening was carried out, and an insulating layer 12, 2nd magnetic pole partial layer 10b can be formed with a sufficient precision also from this point. Therefore, according to the gestalt of this operation, even when the width of recording track is made small, the width of recording track can be specified with a sufficient precision.

[0082] By the way, in connecting a yoke partial layer to the magnetic pole portion which has width of face equal to recording track width of face, and length equal to throat height, in order that the cross section of a magnetic path may decrease rapidly by part for both connection, the saturation of magnetic flux arises in this portion. On the other hand, with the gestalt of this operation, 1st magnetic pole partial layer 10a and the yoke partial layer 18 are connected through 2nd magnetic pole partial layer 10b. Moreover, since the length of 2nd magnetic pole partial layer 10b is larger than the length of 1st magnetic pole partial layer 10a, 2nd magnetic pole partial layer 10b and the yoke partial layer 18 contact in a latus field comparatively. Therefore, according to the gestalt of this operation, it can apply to 1st magnetic pole partial layer 10a from the yoke partial layer 18, the cross section of a magnetic path cannot decrease rapidly, and the saturation of the magnetic flux in the middle of being a magnetic path can be prevented. Consequently, according to the gestalt of this operation, it becomes possible to use efficiently for record the magnetomotive force generated with the thin film coil 16.

[0083] Moreover, with the form of this operation, the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 18 is arranged in the position distant from the pneumatic bearing side 30. Therefore, according to the form of this operation, the writing of the data to fields other than the field which should be recorded, i.e., a side light, can be prevented. Moreover, with the form of this operation, since 1st magnetic pole partial layer 10a and the yoke partial layer 18 are connected through 2nd magnetic pole partial layer 10b with the whole bigger length than throat height, even if it arranges the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 18 in the position distant from the pneumatic bearing side 30 as mentioned above, the cross section of a magnetic path does not decrease rapidly.

[0084] Moreover, with the form of this operation, the thin film coil 16 is arranged to the side of 1st magnetic pole partial layer 10a, and is formed on the flat insulator layer 15. Therefore, according to the form of this operation, it becomes possible to form the thin film coil 16 with a sufficient precision minutely. Furthermore, according to the form of this operation, since the apex section does not exist, the edge of the thin film coil 16 can be arranged near the throat height zero position TH0, i.e., 1st magnetic pole partial layer 10a.

[0085] According to the form of this operation from these things, for example compared with the former, it becomes reducible [magnetic-path length] about 30 to 40%. Furthermore, it can prevent that the magnetomotive force generated with the thin film coil 16 is saturated on the way, and the magnetomotive force generated with the thin film coil 16 can be efficiently used for record. Therefore, according to the form of this operation, it becomes possible to offer the RF property of a recording head, a nonlinear transition shift (for it to be described as NLTS below Non-linear Transition Shift;.), and the thin film magnetic head that was excellent in the over-writing property.

[0086] Moreover, according to the form of this operation, the overall length of the thin film coil 16 can be shortened sharply, without changing a number of turns from a bird clapper as reduction of magnetic-path length is possible. Thereby, since resistance of the thin film coil 16 can be made small, it becomes possible to make small thickness of the part and the thin film coil 16.

[0087] Moreover, with the form of this operation, since the wrap coil insulation layer 17 was formed for the thin film coil 16 arranged in the side of 1st magnetic pole partial layer 10a of an up magnetic pole layer, and 2nd magnetic pole partial layer 10b and flattening of the upper surface of this coil insulation layer 17 was carried out, it becomes possible to form the yoke partial layer 18 formed after that with a sufficient precision.

[0088] Moreover, with the form of this operation, since the record gap layer 9 which consists of inorganic material

from which thin and sufficient isolation voltage is obtained and which is an insulator layer is formed between the lower magnetic pole layer 8 and the thin film coil 16, big isolation voltage can be obtained between the lower magnetic pole layer 8 and the thin film coil 16.

[0089] Moreover, with the form of this operation, since the thin film coil 16 was covered in the coil insulation layer 17 which consists of an inorganic insulating material, it can prevent that a magnetic pole portion projects in a record-medium side by expansion by the heat generated around the thin film coil 16 while using the thin film magnetic head.

[0090] With reference to [the form of the 2nd operation], next drawing 12 , the thin film magnetic head concerning the form of operation of the 2nd of this invention and its manufacture method are explained. In addition, in drawing 12 , (a) shows a cross section perpendicular to a pneumatic bearing side, and (b) shows the cross section parallel to the pneumatic bearing side of a magnetic pole portion.

[0091] The thin film magnetic head concerning the form of this operation prepares a two-layer thin film coil. The process which **********s alternatively and makes the lower magnetic pole layer 8 trim structure by the manufacture method of the thin film magnetic head concerning the form of this operation is the same as the form of the 1st operation. However, with the form of this operation, the lower magnetic pole layer 8 is formed in the large field compared with the form of the 1st operation. Moreover, with the form of this operation, thickness of 2nd magnetic pole partial layer 10b is set to about 2.0-3.0 micrometers. Moreover, it etched, after forming the photo mask for trims which is not illustrated to the field used as the thin film coil bottom, when **********ing the record gap layer 9 with the form of this operation, in order to consider as trim structure, and it has left, without removing the record gap layer 9 in the field used as the thin film coil bottom.

[0092] By the manufacture method of the thin film magnetic head concerning the form of this operation, after considering as trim structure, the insulator layer 15 which consists of an alumina in order to insulate the thin film coil and the lower magnetic pole layer 8 which are mentioned later is formed in the whole at the thickness of about 0.3-0.5 micrometers. Next, the 1st layer portion 21 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on an insulator layer 15 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The 1st layer portion 21 of a thin film coil is formed so that it may be wound focusing on magnetic layers 11 and 13, and the part is arranged in the side of 1st magnetic pole partial layer 10a. In addition, in drawing 12 (a), sign 21a shows the connection for connecting with the 2nd layer portion which mentions the 1st layer portion 21 of a thin film coil later.

[0093] Next, the coil insulation layer 22 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 22 is ground and flattening processing of the front face is carried out until 2nd magnetic pole partial layer 10b and a magnetic layer 13 are exposed. Although the 1st layer portion 21 of a thin film coil is not exposed, you may make it exposed [this 1st layer portion 21] by drawing 12 (a) here. When it is made exposed [the 1st layer portion 21], a wrap insulator layer is formed for the 1st layer portion 21.

[0094] Next, on connection 21a, the coil insulation layer 22 is **********ed partially and a contact hole is formed. Next, the 2nd layer portion 23 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on the coil insulation layer 22 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. In addition, in drawing 12 (a), sign 23a shows the connection for connecting the 2nd layer portion 23 of a thin film coil to connection 21a of the 1st layer portion 21 through a contact hole.

[0095] Next, a photoresist layer 24 is formed at a predetermined pattern on the coil insulation layer 22 and the 2nd layer portion 23 of a thin film coil. Next, the yoke partial layer 25 used as the yoke portion of an up magnetic pole layer is formed at the thickness of about 2.0-3.0 micrometers on 2nd magnetic pole partial layer 10b, a photoresist layer 24, and a magnetic layer 13. Using NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material, the yoke partial layer 25 may be formed in a predetermined pattern by the galvanizing method, using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material, **********s alternatively and may be formed in a predetermined pattern by ion milling etc. after a spatter. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material. Moreover, it is good also as structure which laid the insulator layer of an inorganic system, and magnetic layers, such as a permalloy, on top of many layers for the yoke partial layer 25 because of an improvement of a RF property.

[0096] Moreover, the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 25 is arranged in the position near the throat height zero position especially with the form of the position distant from the pneumatic bearing side 30 only 0.5-1.0 micrometers, and this operation.

[0097] Next, the overcoat layer 26 which consists of an alumina is formed in the thickness of 20-40 micrometers, flattening of the front face is carried out to the whole, and the pad for electrodes which is not illustrated is formed on it.

Finally, polish processing of a slider is performed, the pneumatic bearing side 30 of the thin film magnetic head containing a recording head and the reproducing head is formed, and the thin film magnetic head concerning the gestalt of this operation is completed.

[0098] With the form of this operation, the up magnetic pole layer which consists of 1st magnetic pole partial layer 10a, 2nd magnetic pole partial layer 10b, magnetic layers 11 and 13, and a yoke partial layer 25 is equivalent to the 2nd magnetic layer in this invention.

[0099] In this invention, since the 2nd layer portion 23 of a thin film coil was formed on the coil insulation layer 22 by which flattening was carried out, it becomes possible to form the 2nd layer portion 23 with a sufficient precision minutely.

[0100] The composition of others in the form of this operation, the operation, and the effect are the same as the form of the 1st operation.

[0101] With reference to [the form of the 3rd operation] next drawing 13 , or drawing 18 , the thin film mind head concerning the form of operation of the 3rd of this invention and its manufacture method are explained. In addition, in drawing 13 or drawing 18 , (a) shows a cross section perpendicular to a pneumatic bearing side, and (b) shows the cross section parallel to the pneumatic bearing side of a magnetic pole portion.

[0102] The thin film magnetic head concerning the form of this operation prepares a two-layer thin film coil. As shown in drawing 13 by the manufacture method of the thin film magnetic head concerning the form of this operation, the process which forms the lower magnetic pole layer 8 is the same as the form of the 1st operation. However, with the form of this operation, the lower magnetic pole layer 8 is formed in the large field compared with the form of the 1st operation.

[0103] With the form of this operation next, as shown in drawing 14 , the record gap layer 9 which consists of an insulating material is formed on the lower magnetic pole layer 8 at the thickness of 0.2-0.3 micrometers. Next, for magnetic-path formation, the record gap layer 9 is **********ed partially and contact hole 9a is formed. Next, in the position near [by the side of the pneumatic bearing side 30 of the record gap layer 9] the edge, 1st magnetic pole partial layer 10a of an up magnetic pole layer is formed on the record gap layer 9 at the thickness of about 0.5-1.0 micrometers. At this time, the magnetic layer 11 which consists of a magnetic material for magnetic-path formation on contact hole 9a for magnetic-path formation is simultaneously formed in the thickness of about 0.5-1.0 micrometers. The configuration of 1st magnetic pole partial layer 10a at this time is the same as that of the form of the 1st operation.

[0104] Next, the insulating layer 12 which consists of an alumina is formed in the whole at the thickness of about 1.0-2.0 micrometers. Next, for example by CMP, an insulating layer 12 is ground and flattening processing of the front face is carried out until 1st magnetic pole partial layer 10a and a magnetic layer 11 are exposed. In drawing 14 (a), the boundary position of 1st magnetic pole partial layer 10a and an insulating layer 12 turns into a throat height zero position.

[0105] Next, as shown in drawing 15 , 2nd magnetic pole partial layer 10b of an up magnetic pole layer is formed on 1st magnetic pole partial layer 10a at the thickness of about 2.0-3.0 micrometers. At this time, a magnetic layer 13 is simultaneously formed on a magnetic layer 11 at the thickness of about 2.0-3.0 micrometers. 2nd magnetic pole partial layer 10b has the width of face of the portion in contact with 1st magnetic pole partial layer 10a equal to recording track width of face, and the whole length is larger than the length of 1st magnetic pole partial layer 10a in a magnetic pole portion.

[0106] Next, 1st magnetic pole partial layer 10a and an insulating layer 12 are **********ed by the ion milling for example, using argon system gas by using 2nd magnetic pole partial layer 10b as a mask. Thereby, in the portion in contact with 2nd magnetic pole partial layer 10b, the width of face of 1st magnetic pole partial layer 10a becomes equal to the width of face of the 2nd magnetic pole partial layer, i.e., recording track width of face.

[0107] Next, in order to consider as trim structure, the photo mask 14 for trims is formed on portions other than the field which should **********. Next, the record gap layer 9 is alternatively **********ed by dry etching by using 1st magnetic pole partial layer 10a and 2nd magnetic pole partial layer 10b, and the photo mask 14 for trims as a mask. At this time, it has left with the form of this operation, without removing the record gap layer 9 in the field used as the thin film coil bottom mentioned later. Moreover, RIE which used gas, such as chlorine-based gas of BCl2 and Cl2 grade and fluorine system gas of CF4 and SF6 grade, is used for the dry etching at this time. Next, it considers as trim structure as **********s about about 0.3-0.6 micrometers alternatively and showed the lower magnetic pole layer 8 to drawing 15 (b), for example by the ion milling using argon system gas. Next, the photo mask 14 for trims is removed.

[0108] Next, as shown in drawing 16 , the insulator layer 15 which consists of an alumina is formed in the whole at the thickness of about 0.3-0.5 micrometers. Next, the 1st layer portion 31 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on an insulator layer 15 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The 1st layer portion 31 of a thin film coil is formed so that it may

be wound focusing on magnetic layers 11 and 13, and the part is arranged in the side of 1st magnetic pole partial layer 10a. In addition, in drawing 16 (a), sign 31a shows the connection for connecting with the 2nd layer portion which mentions the 1st layer portion 31 of a thin film coil later.
[0109] Next, as shown in drawing 17 , the coil insulation layer 32 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 32 is ground and flattening processing of the front face is carried out until 2nd magnetic pole partial layer 10b and a magnetic layer 13 are exposed. Although the 1st layer portion 31 of a thin film coil is not exposed, you may make it exposed [this 1st layer portion 31] by drawing 17 (a) here. When it is made exposed [the 1st layer portion 31], a wrap insulator layer is formed for the 1st layer portion 31.
[0110] Next, it consists of a magnetic material on 2nd magnetic pole partial layer 10b and the coil insulation layer 32, and the connection layer 33 for connecting 2nd magnetic pole partial layer 10b and the yoke partial layer mentioned later is formed in the thickness of about 2.0-3.0 micrometers. At this time, a magnetic layer 34 is simultaneously formed on a magnetic layer 13 at the thickness of about 2.0-3.0 micrometers.
[0111] The end face by the side of the pneumatic bearing side 30 of the connection layer 33 is arranged in the position near the throat height zero position especially with the form of the position distant from the pneumatic bearing side 30 only 0.5-1.0 micrometers, and this operation. The length of the connection layer 33 is set to about 3.0 micrometers. In addition, in the pneumatic bearing side 30 of the connection layer 33, although the end face by the side of the pneumatic bearing side 30 of the yoke partial layer mentioned later can be kept away from the pneumatic bearing side 30 so that the position of the end face of an opposite side keeps away from the pneumatic bearing side 30, magnetic-path length will become long. Therefore, the pneumatic bearing side 30 of 2nd magnetic pole partial layer 10b of the pneumatic bearing side 30 of the connection layer 33 is [considering as the position which the connection layer 33 left the thickness grade to the opposite side] desirable [the position of the end face of an opposite side / the position of the end face of an opposite side to the pneumatic bearing side 30].
[0112] Using NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material, the connection layer 33 may be formed in a predetermined pattern by the galvanizing method, using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material, **********s alternatively and may be formed in a predetermined pattern by ion milling etc. after a spatter. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material.
[0113] Next, the insulator layer 35 which consists of an alumina is formed in the whole at the thickness of about 0.3-0.5 micrometers. Next, on connection 31a, an insulator layer 35 and the coil insulation layer 32 are **********ed partially, and a contact hole is formed. Next, the 2nd layer portion 36 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on an insulator layer 35 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The 2nd layer portion 36 of a thin film coil is formed so that it may be wound focusing on a magnetic layer 34, and the part is arranged in the side of the connection layer 33. In addition, in drawing 17 (a), sign 36a shows the connection for connecting the 2nd layer portion 36 of a thin film coil to connection 31a of the 1st layer portion 31 through a contact hole.
[0114] Next, as shown in drawing 18 , the coil insulation layer 37 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 37 is ground and flattening processing of the front face is carried out until the connection layer 33 and a magnetic layer 34 are exposed. Although the 2nd layer portion 36 of a thin film coil is not exposed, you may make it exposed [the 2nd layer portion 36] by drawing 18 (a) here. When it is made exposed [the 2nd layer portion 36], a wrap insulator layer is formed for the 2nd layer portion 36.
[0115] Next, the yoke partial layer 38 used as the yoke portion of an up magnetic pole layer is formed at the thickness of about 2.0-3.0 micrometers on the connection layer 33, the coil insulation layer 37, and a magnetic layer 34. The material and the formation method for forming the yoke partial layer 38 are the same as that of the yoke partial layer 18 in the gestalt of the 1st operation.
[0116] Moreover, the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 38 is arranged in the position distant from the pneumatic bearing side 30, and the position which is distant from the pneumatic bearing side 30 from a throat height zero position with especially the form of this operation.
[0117] Next, the overcoat layer 39 which consists of an alumina is formed in the thickness of 20-40 micrometers, flattening of the front face is carried out to the whole, and the pad for electrodes which is not illustrated is formed on it. Finally, polish processing of a slider is performed, the pneumatic bearing side 30 of the thin film magnetic head containing a recording head and the reproducing head is formed, and the thin film magnetic head concerning the form of this operation is completed.

[0118] With the form of this operation, 2nd magnetic pole partial layer 10b and the yoke partial layer 38 are connected through the connection layer 33. With the form of this operation, the up magnetic pole layer which consists of 1st magnetic pole partial layer 10a, 2nd magnetic pole partial layer 10b, the connection layer 33, magnetic layers 11, 13, and 34, and a yoke partial layer 38 is equivalent to the 2nd magnetic layer in this invention.
[0119] With the form of this operation, while arranging the 1st layer portion 31 of a thin film coil to the side of 1st magnetic pole partial layer 10a of an up magnetic pole layer and forming it on the flat insulator layer 15, the 2nd layer portion 36 of a thin film coil is arranged to the side of the connection layer 33, and is formed on the flattening insulator layer 35. Therefore, according to the form of this operation, it becomes possible to both form minutely the 1st layer portion 31 and the 2nd layer portion 36 of a thin film coil with a sufficient precision, and reduction of magnetic-path length is attained.
[0120] Moreover, with the gestalt of this operation, since the wrap coil insulation layer 37 was formed for the 2nd layer portion 36 of the thin film coil arranged in the side of the connection layer 33 and flattening of the upper surface of this coil insulation layer 37 was carried out, it becomes possible to form the yoke partial layer 38 formed after that with a sufficient precision.
[0121] The composition of others in the gestalt of this operation, the operation, and the effect are the same as the gestalt of the 1st operation.
[0122] With reference to [the form of the 4th operation] next drawing 19 , or drawing 24 , the thin film mind head concerning the form of operation of the 4th of this invention and its manufacture method are explained. In addition, in drawing 19 or drawing 24 , (a) shows a cross section perpendicular to a pneumatic bearing side, and (b) shows the cross section parallel to the pneumatic bearing side of a magnetic pole portion.
[0123] The thin film magnetic head concerning the form of this operation prepares a two-layer thin film coil. The process which forms the record gap layer 9 by the manufacture method of the thin film magnetic head concerning the form of this operation is the same as the form of the 3rd operation.
[0124] With the form of this operation next, as shown in drawing 19 next, for magnetic-path formation, the record gap layer 9 is **********ed partially and contact hole 9a is formed. Next, in the position near [by the side of the pneumatic bearing side 30 of the record gap layer 9] the edge, 1st magnetic pole partial layer 10a of an up magnetic pole layer is formed on the record gap layer 9 at the thickness of about 0.5-1.0 micrometers. At this time, the magnetic layer 11 which consists of a magnetic material for magnetic-path formation on contact hole 9a for magnetic-path formation is simultaneously formed in the thickness of about 0.5-1.0 micrometers. The configuration of 1st magnetic pole partial layer 10a at this time is the same as that of the form of the 1st operation.
[0125] Moreover, with the form of this operation, it is on the record gap layer 9, and the bottom raising pattern 41 is formed in the field to which the connection for connecting to the 2nd layer portion the 1st layer portion of the thin film coil mentioned later is arranged at the thickness of about 0.5-1.0 micrometers. Especially the material of this bottom raising pattern 41 is not limited. However, it is desirable to make material of the bottom raising pattern 41 into the same magnetic material as 1st magnetic pole partial layer 10a of an up magnetic pole layer and a magnetic layer 11, and to form the bottom raising pattern 41 simultaneously with 1st magnetic pole partial layer 10a of an up magnetic pole layer and a magnetic layer 11.
[0126] Next, the insulating layer 12 which consists of an alumina is formed in the whole at the thickness of about 1.0-2.0 micrometers. Next, for example by CMP, an insulating layer 12 is ground and flattening processing of the front face is carried out until the 1st magnetic pole partial layer 10a, magnetic layer 11, and bottom raising pattern 41 are exposed. In drawing 19 (a), the boundary position of 1st magnetic pole partial layer 10a and an insulating layer 12 turns into a throat height zero position.
[0127] Next, as shown in drawing 20 , 2nd magnetic pole partial layer 10b of an up magnetic pole layer is formed on 1st magnetic pole partial layer 10a at the thickness of about 2.0-3.0 micrometers. At this time, a magnetic layer 13 is simultaneously formed on a magnetic layer 11 at the thickness of about 2.0-3.0 micrometers. 2nd magnetic pole partial layer 10b has the width of face of the portion in contact with 1st magnetic pole partial layer 10a equal to recording track width of face, and the whole length is larger than the length of 1st magnetic pole partial layer 10a in a magnetic pole portion.
[0128] Next, 1st magnetic pole partial layer 10a and an insulating layer 12 are **********ed by the ion milling for example, using argon system gas by using 2nd magnetic pole partial layer 10b as a mask. Thereby, in the portion in contact with 2nd magnetic pole partial layer 10b, the width of face of 1st magnetic pole partial layer 10a becomes equal to the width of face of the 2nd magnetic pole partial layer, i.e., recording track width of face.
[0129] Next, the photo mask 14 for trims is formed on portions other than the field which should ********** in order to consider as trim structure, as shown in drawing 21 . Next, the record gap layer 9 is alternatively **********ed by dry etching by using 1st magnetic pole partial layer 10a and 2nd magnetic pole partial layer 10b, and the photo mask

14 for trims as a mask. At this time, it has left with the form of this operation, without removing the record gap layer 9 in the field used as the thin film coil bottom mentioned later. Moreover, RIE which used gas, such as chlorine-based gas of BCl2 and Cl2 grade and fluorine system gas of CF4 and SF6 grade, is used for the dry etching at this time. Next, it considers as trim structure as **********s about about 0.3-0.6 micrometers alternatively and showed the lower magnetic pole layer 8 to drawing 21 (b), for example by the ion milling using argon system gas. Next, the photo mask 14 for trims is removed.

[0130] Next, as shown in drawing 22 , the 1st layer portion 31 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on the record gap layer 9 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The 1st layer portion 31 of a thin film coil is formed so that it may be wound focusing on magnetic layers 11 and 13, and the part is arranged in the side of 1st magnetic pole partial layer 10a. With the form of this operation, connection 31a for connecting with the 2nd layer portion which mentions the 1st layer portion 31 of a thin film coil later is formed on the bottom raising pattern 41.

[0131] Next, as shown in drawing 23 , the coil insulation layer 32 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 32 is ground and flattening processing of the front face is carried out until 2nd magnetic pole partial layer 10b, a magnetic layer 13, and connection 31a are exposed. Although the 1st layer portion 31 of a thin film coil is not exposed, you may make it exposed [this 1st layer portion 31] by drawing 23 (a) here. When it is made exposed [the 1st layer portion 31], a wrap insulator layer is formed for the 1st layer portion 31.

[0132] Next, it consists of a magnetic material on 2nd magnetic pole partial layer 10b and the coil insulation layer 32, and the connection layer 33 for connecting 2nd magnetic pole partial layer 10b and the yoke partial layer mentioned later is formed in the thickness of about 2.0-3.0 micrometers. At this time, a magnetic layer 34 is simultaneously formed on a magnetic layer 13 at the thickness of about 2.0-3.0 micrometers. The material of the connection layer 33, a size, and arrangement are the same as that of the gestalt of the 3rd operation.

[0133] Next, the 2nd layer portion 36 of the thin film coil which consists of copper is formed for example, by the frame galvanizing method on the coil insulation layer 32 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. The 2nd layer portion 36 of a thin film coil is formed so that it may be wound focusing on a magnetic layer 34, and the part is arranged in the side of the connection layer 33. Connection 36a of the 2nd layer portion 36 is formed on connection 31a of the 1st layer portion 31.

[0134] Next, as shown in drawing 24 , the coil insulation layer 37 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, for example by CMP, the coil insulation layer 37 is ground and flattening processing of the front face is carried out until the connection layer 33 and a magnetic layer 34 are exposed. Although the 2nd layer portion 36 of a thin film coil is not exposed, you may make it exposed [the 2nd layer portion 36] by drawing 24 (a) here. When it is made exposed [the 2nd layer portion 36], a wrap insulator layer is formed for the 2nd layer portion 36.

[0135] Next, the yoke partial layer 38 used as the yoke portion of an up magnetic pole layer is formed at the thickness of about 2.0-3.0 micrometers on the connection layer 33, the coil insulation layer 37, and a magnetic layer 34. The material and the formation method for forming the yoke partial layer 38 are the same as that of the yoke partial layer 18 in the form of the 1st operation.

[0136] Moreover, the end face by the side of the pneumatic bearing side 30 of the yoke partial layer 38 is arranged in the position distant from the pneumatic bearing side 30, and the position which is distant from the pneumatic bearing side 30 from a throat height zero position with especially the form of this operation.

[0137] Next, the overcoat layer 39 which consists of an alumina is formed in the thickness of 20-40 micrometers, flattening of the front face is carried out to the whole, and the pad for electrodes which is not illustrated is formed on it. Finally, polish processing of a slider is performed, the pneumatic bearing side 30 of the thin film magnetic head containing a recording head and the reproducing head is formed, and the thin film magnetic head concerning the form of this operation is completed.

[0138] With the form of this operation, it is on the record gap layer 9, and the bottom raising pattern 41 is formed in the field to which connection 31a for connecting the 1st layer portion 31 of a thin film coil to the 2nd layer portion 36 is arranged, and connection 31a is formed on this bottom raising pattern 41. Therefore, the coil insulation layer 32 is ground by CMP, and connection 31a also exposes a front face at the process which carries out flattening processing with 2nd magnetic pole partial layer 10b and a magnetic layer 13, for example. Therefore, according to the form of this operation, in order to connect connection 31a of the 1st layer portion 31 of a thin film coil, and connection 36a of the 2nd layer portion 36, in the portion on connection 31a, the process which forms a contact hole in the coil insulation layer 32 becomes unnecessary. Moreover, if the bottom raising pattern 41 is formed simultaneously with 1st magnetic pole partial layer 10a of an up magnetic pole layer, and a magnetic layer 11, the number of processes will not increase

for formation of the bottom raising pattern 41.

[0139] The composition of others in the form of this operation, the operation, and the effect are the same as the form of the 3rd operation.

[0140] this invention is not limited to the gestalt of each above-mentioned implementation, but various change is possible for it. For example, although the gestalt of each above-mentioned implementation explained the thin film magnetic head of the structure which read to the base side, formed MR element of business, and carried out the laminating of the induction-type MAG sensing element for writing on it, you may make this built-up sequence reverse.

[0141] That is, it may write in a base side, the induction-type MAG sensing element of business may be formed, and MR element for reading may be formed on it. Such structure is realizable by forming in a base side by using as a lower magnetic pole layer the magnetic film which has the function of the up magnetic pole layer shown in the gestalt of the above-mentioned implementation for example, and forming the magnetic film which has the function of the lower magnetic pole layer it was indicated to the gestalt of the above-mentioned implementation that countered it as an up magnetic pole layer through a record gap film. In this case, it is desirable to make the up magnetic pole layer of an induction-type MAG sensing element and the lower shield layer of MR element make it serve a double purpose.

[0142] Moreover, this invention is applicable also to the thin film magnetic head only for the records equipped only with the induction-type MAG sensing element, and the thin film magnetic head which performs record and reproduction by the induction-type MAG sensing element.

[0143]

[Effect of the Invention] As explained above, according to the thin film magnetic head according to claim 1 to 12 Since the 1st magnetic pole partial layer of one magnetic layer has length equal to throat height and it was made to have width of face with the 1st magnetic pole partial layer of one magnetic layer and the 2nd magnetic pole partial layer equal to recording track width of face It becomes possible to make width of face of the 1st magnetic pole partial layer into width of face equal to recording track width of face after formation of the 2nd magnetic pole partial layer. Therefore, according to this invention, it becomes possible to form the 1st magnetic pole partial layer so that it may have larger width of face than recording track width of face in the beginning, and it becomes possible to form the 1st magnetic pole partial layer with a sufficient precision. Moreover, according to this invention, since the whole length is larger than the length of the 1st magnetic pole partial layer, the 2nd magnetic pole partial layer becomes possible [forming the 2nd magnetic pole partial layer with a sufficient precision]. From these things, even when the width of recording track of an induction-type MAG sensing element is made small according to this invention, the effect of becoming possible to specify the width of recording track and throat height with a sufficient precision is done so. Furthermore, according to this invention, the 1st magnetic pole partial layer and yoke partial layer are connected through the 2nd magnetic pole partial layer, and since the length of the 2nd magnetic pole partial layer is larger than the length of the 1st magnetic pole partial layer, it contacts in the field where the 2nd magnetic pole partial layer and yoke partial layer are comparatively large. Therefore, according to this invention, the effect of becoming possible to be able to prevent applying to the 1st magnetic pole partial layer from a yoke partial layer, and the cross section of a magnetic path decreasing rapidly, and to prevent the saturation of the magnetic flux in the middle of a magnetic path is done so.

[0144] Moreover, since the end face by the side of the medium opposed face of a yoke partial layer is arranged in the position distant from the medium opposed face according to the thin film magnetic head according to claim 2, the effect that the writing of the data to fields other than the field which should be recorded can be prevented further is done so.

[0145] Moreover, since according to the thin film magnetic head according to claim 3 it has been arranged in the side of the 1st magnetic pole partial layer and the field by the side of the 2nd magnetic pole partial layer was equipped with the insulating layer by which flattening was carried out with the field of another side of the 1st magnetic pole partial layer, the effect of becoming possible further to form the 2nd magnetic pole partial layer with a sufficient precision is done so.

[0146] Moreover, since some thin film coils [at least] are arranged in the side of the 1st magnetic pole partial layer which specifies throat height according to the thin film magnetic head according to claim 4, further, some [at least] edges of a thin film coil can be arranged near the edge of the 1st magnetic pole partial layer, consequently the effect that reduction of magnetic-path length is attained is done so.

[0147] Moreover, since it had the coil-insulation layer to which some thin film coils [at least] arranged in the side of the 1st magnetic pole partial layer were covered further, and flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer according to the thin film magnetic head according to claim 5, the effect become possible to form further the layer which adjoins an insulating layer with a sufficient precision does so.

[0148] According to the thin film magnetic head according to claim 7, moreover, a thin film coil It has the 1st portion arranged in the side of the 1st magnetic pole partial layer, and the 2nd portion arranged between this 1st portion and a yoke partial layer. The thin film magnetic head covers further the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer. Since it has the coil insulation layer to which flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer and the 2nd portion of a thin film coil is arranged between the coil insulation layer and the yoke partial layer Furthermore, the effect of becoming possible to form the 2nd portion of a thin film coil with a sufficient precision is done so.
[0149] According to the thin film magnetic head according to claim 10, moreover, one magnetic layer It has a connection layer for connecting the 2nd magnetic pole partial layer and yoke partial layer. furthermore, a thin film coil It has the 1st portion arranged in the side of the 1st magnetic pole partial layer, and the 2nd portion arranged in the side of a connection layer. the thin film magnetic head Furthermore, the 1st coil insulation layer to which the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer was covered, and flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer, The 2nd portion of the thin film coil arranged in the side of a connection layer is covered, and since the field by the side of a yoke partial layer was equipped with the 2nd coil insulation layer by which flattening was carried out with the field by the side of the yoke partial layer in a connection layer, the effect of becoming possible further to form a yoke partial layer with a sufficient precision is done so.
[0150] moreover, by the manufacture method of the thin film magnetic head according to claim 13 to 33 The process in which length [in / a magnetic pole portion / in the process which forms the 2nd magnetic layer] forms the 1st magnetic pole partial layer equal to throat height, The process which forms the 2nd larger magnetic pole partial layer than the length of the 1st magnetic pole partial layer [in / a magnetic pole portion / the width of face of the portion in contact with the 1st magnetic pole partial layer is equal to recording track width of face, and / in the whole length], In the portion in contact with the 1st magnetic pole partial layer and the 2nd magnetic pole partial layer, the process which **********s the 1st magnetic pole partial layer by using the 2nd magnetic pole partial layer as a mask, and the process which forms a yoke partial layer are included so that the width of face of the 1st magnetic pole partial layer may become equal to the width of face of the 2nd magnetic pole partial layer. Therefore, according to this invention, it becomes possible to form the 1st magnetic pole partial layer so that it may have larger width of face than recording track width of face in the beginning, and it becomes possible to form the 1st magnetic pole partial layer with a sufficient precision. Moreover, according to this invention, since the whole length is larger than the length of the 1st magnetic pole partial layer, the 2nd magnetic pole partial layer becomes possible [forming the 2nd magnetic pole partial layer with a sufficient precision]. From these things, even when the width of recording track of an induction-type MAG sensing element is made small according to this invention, the effect of becoming possible to specify the width of recording track and throat height with a sufficient precision is done so. Furthermore, according to this invention, the 1st magnetic pole partial layer and yoke partial layer are connected through the 2nd magnetic pole partial layer, and since the length of the 2nd magnetic pole partial layer is larger than the length of the 1st magnetic pole partial layer, the 2nd magnetic pole partial layer and yoke partial layer contact in a latus field comparatively. Therefore, according to this invention, the effect of becoming possible to be able to prevent applying to the 1st magnetic pole partial layer from a yoke partial layer, and the cross section of a magnetic path decreasing rapidly, and to prevent the saturation of the magnetic flux in the middle of a magnetic path is done so.
[0151] Moreover, since the end face by the side of the medium opposed face of a yoke partial layer has been arranged in the position distant from the medium opposed face according to the manufacture method of the thin film magnetic head according to claim 14, the effect that the writing of the data to fields other than the field which should be recorded can be prevented further is done so.
[0152] Moreover, since it is arranged in the side of the 1st magnetic pole partial layer and it made the field by the side of the 2nd magnetic pole partial layer include further the process which forms the insulating layer by which flattening was carried out with the field of another side of the 1st magnetic pole partial layer according to the manufacture method of the thin film magnetic head according to claim 15, the effect become possible further to form the 2nd magnetic pole partial layer with a sufficient precision does so.
[0153] Moreover, according to the manufacture method of the thin film magnetic head according to claim 16, since some thin film coils [at least] were arranged to the side of the 1st magnetic pole partial layer, further, some [at least] edges of a thin film coil can be arranged near the edge of the 1st magnetic pole partial layer, consequently the effect that reduction of magnetic-path length is attained is done so.
[0154] According to the manufacture method of the thin film magnetic head according to claim 17, moreover, further Since it was made to include the process which forms the coil insulation layer to which some thin film coils [at least] arranged in the side of the 1st magnetic pole partial layer were covered, and flattening of the field by the side of a yoke

partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer Furthermore, the effect of becoming possible to form the layer which adjoins an insulating layer with a sufficient precision is done so.

[0155] Moreover, according to the manufacture method of the thin film magnetic head according to claim 19, the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer is covered. Since the field by the side of a yoke partial layer forms the coil insulation layer by which flattening was carried out with the field of another side of the 2nd magnetic pole partial layer and arranged the 2nd portion of a thin film coil between the coil insulation layer and the yoke partial layer Furthermore, the effect of becoming possible to form the 2nd portion of a thin film coil with a sufficient precision is done so.

[0156] Moreover, according to the manufacture method of the thin film magnetic head according to claim 22, the connection layer for connecting the 2nd magnetic pole partial layer and yoke partial layer is prepared. Arrange the 1st portion of a thin film coil to the side of the 1st magnetic pole partial layer, and the 2nd portion of a thin film coil is arranged to the side of a connection layer. Furthermore, the process which forms the 1st coil insulation layer to which the 1st portion of the thin film coil arranged in the side of the 1st magnetic pole partial layer was covered, and flattening of the field by the side of a yoke partial layer was carried out with the field of another side of the 2nd magnetic pole partial layer, Since the 2nd portion of the thin film coil arranged in the side of a connection layer is covered and it was made for the field by the side of a yoke partial layer to include the process which forms the 2nd coil insulation layer by which flattening was carried out with the field by the side of the yoke partial layer in a connection layer Furthermore, the effect of becoming possible to form a yoke partial layer with a sufficient precision is done so.

[Translation done.]